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THE RACES OF *HALIOTIS FULGENS* PHILIPPI  
(MOLLUSCA: GASTROPODA)

BY

ROBERT R. TALMADGE  
*Willow Creek, California*

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For a number of years there has been some confusion among malacologists as to the status of certain populations of *Haliotis fulgens* Philippi 1845. Relatively few names, each rather well defined, have been applied to this species, and there is no question concerning the synonymy and priority of these. However, some malacologists declare that there is a single form with only minor local variations, while others recognize two geographical races, one of which appears to be based upon features that can be found in almost any population of *H. fulgens*. It is probable that much of this difference of opinion is based on the examination of a rather small number of specimens, as few collections have large series of shells from various localities. Because of limitations of space, the species is usually represented only by a growth series, with perhaps a few odd items.

Perhaps the largest and most complete collection of *Haliotis fulgens* is in the San Diego Natural History Museum. Mr. Emery P. Chace, Curator of Conchology at that institution, kindly made available to me their comprehensive collection of this species, taken in many localities, some of which are represented in few collections. From a study of these, augmented by examination of most of the major malacological collections in the United States, I think a clearer understanding of this species and its variations may be obtained.

VARIATION AND DISTRIBUTION

Like other haliotids, this species exhibits definite variation related to age. Reeve (1846) figured and described a juvenile shell as *Haliotis planilirata*, the type of which is in the British Museum (Natural History). Juvenile specimens are usually more elongate than adults; they lack the muscle scar, and have a more or less pure silvery nacre. The muscle scar, as well as the brilliant green, pink, and blue coloration, starts to develop in shells of approximately 100 to 125 mm. in length, and this development continues until the animals reach maturity. As the animal becomes older the shell deepens and becomes more rounded, with a dark blue coloration becoming predominant. Dark stains, probably of organic origin, cover portions of the columellar plate and interior, and the muscle scar becomes larger and rugose. Such old specimens are usually so eroded, by the action of borers and by wear, that most of the sculpturing is lost. The number of open siphonal pores usually decreases; one specimen examined is totally imperforate.

At present the species appears to be restricted to the warmer waters of the Pacific coast of North America, from the vicinity of Magdalena Bay, Baja California (approximately 24° N), north to Point Conception, California (approximately 34° N), including the offshore islands. There are some references to the species at Cape San Lucas, Baja California, but I have not been able to verify these occurrences. North of Point Conception, the species is known from several specimen records. There is a set of juvenile shells in the collection of the California Academy of Sciences taken from near Monterey, California. Mr. Keith Cox (pers. comm.) has also noted juveniles in that area. I have one in my collection from near Carmel, California. Keep (1935) refers to *Haliotis fulgens* from Monterey.

There is a story told among the abalone divers that in past years the Japanese divers operating out of Monterey, who often worked as far south as the Channel Islands, attempted to establish this species in the north by planting the animals as they returned home. If this is true, it could explain the northern specimens; perhaps the plantings did not prosper, but a few individuals were able to survive in isolated spots, producing the juveniles that we find today.

## FOSSIL RECORD

The family Haliotidae is poorly represented by fossil specimens. Perhaps one of the earliest species is *Haliotis lomaensis* Anderson, late Cretaceous, from San Diego, California. This single specimen, in the California Academy of Sciences, is a well developed haliotid comparable to Recent species.

Based upon shape and sculpturing there are two fossil examples which could be considered to pertain to *Haliotis fulgens*. Woodring described *Haliotis lasia* from the Miocene of San Luis Obispo County, California. The site is not far north of the main part of the present range. With at least one paratype, the type is in the United States National Museum (no. 371767). Another similar, if not identical, species, *Haliotis elsmersensis* Voke, is represented by no. 32465 in the Museum of Invertebrate Paleontology, University of California, Berkeley. This is referred to the Pliocene of Los Angeles County, California. The locality is well within the range of the Recent species.

After examination of both of these type specimens, I am of the opinion that they represent the same species; both are either *Haliotis fulgens* or they are an early form of the complex which contains *H. fulgens*, *H. walallensis* and the European *H. tuberculata*.

Hertlein (1957) recorded *Haliotis fulgens* at Punta Púpito in the Gulf of California, dating the deposits as Pleistocene. As far as is known, the species does not inhabit that area today. Other paleontologists working with the elevated marine terraces of Pleistocene age have found the species along the coast of the Californias well within the range of the Recent form.

## METHOD

In an attempt to evaluate the living populations, I had available for study, over a period of time, several hundred examples. The locality of each of these was plotted on a large scale map. A work sheet was prepared covering the nacre coloration, number and type of open siphonal pores, measurements (length, width, height, height of spire) and ratios, and variation in the sculpturing. Soft parts were compared, especially the formation of the epipodium, the fleshy girdle which encircles the muscular foot.

Comparison of the soft parts indicated that there was a definite, persistent similarity, enough to establish that a single species was present. A study of the shells revealed non-clinal variation that could be used to separate populations from certain regions.

The coloration of the nacre and the number of open pores were so similar in all age groups, and in shells from all localities, that separation on this basis was impractical. It was found that the ratios of certain measurements of the shell from at least two areas indicated a definite separation, and when combined with the sculpturing furnished evidence of two distinct geographical races. When sculpturing alone was considered, it was noted that there were three definite types, two of which merged. As the forms of sculpturing were plotted on a map, it was noted that they fell into distinct geographical areas, and the merging type of sculpturing was found to be at the point of contact of two such regions. Talmadge (1962, 1963) indicated that this was as good a diagnostic feature as was available while working on populations of *Haliotis varia* Linnaeus, and these same characteristics proved useful in an attempt to evaluate the populations of *H. fulgens*.

## TAXONOMY

At the present time, the variations in the sculpturing indicate two distinct populations on the mainland coast of the Californias, and the nearby offshore islands, with a third separate population, differing in both sculpturing and ratios, on Guadalupe Island. Based on this data, I recognize the following races of *Haliotis fulgens*.

*Haliotis fulgens* Philippi

Range. — Magdalena Bay, Baja California, north to Monterey, California, including the offshore islands.

*Haliotis fulgens fulgens* Philippi

*Haliotis fulgens* Philippi, 1845, Zeits. f. Malak. 2, p. 150

*Haliotis splendens* Reeve, 1846, Conch. Icon. 3, sp. 9

*Haliotis fulgens* Philippi, 1847, Abbil. u. Besch., Tab. VIII, fig. 1a

*Haliotis fulgens* Philippi, Cox, 1962, Fish. Bull. 118, p. 32

*Type*.—Lost? Oldroyd (1927:234) gives the location of the type as "Philippi Collection, Chile."

*Type locality*.—Philippi (1845) gave only "Patria", but in 1847 used "Patria California." Reeve (1846) used "Hab. California" for *H. splendens* and "Hab.?" for *H. planilirata*.

*Remarks*.—This is the form which has been best figured and of which specimens are found in most collections. It is one of the commercially taken abalone in southern California and northern Baja California, where it is known as either Green or Blue Abalone. It is a medium elevated, ovate shell when adult, with a rather large, brilliant muscle scar, either greenish or bluish. The interior nacre is shaded with hues of pink, green, and blue, which become dark and brilliant with age. Very old specimens show dark stains and a rather dark nacreous interior. The sculpturing consists of numerous, rather irregular, rounded small cords. The siphonal angle is rounded and the five to seven open pores are on small, slightly elevated projections.

This form is found from Point Conception south to Cedros Island. There are some color phases, usually in Mexican waters. In the vicinity of Punta Banda, Ensenada, and the Todos Santos Islands, Baja California, there is a strong tendency for specimens to have a yellowish or golden wash over the interior nacre. Near Corona del Mar, California, specimens are a rather pale green, with white or silvery nacre. In these areas the shape, sculpturing, and size of the shell are similar to those features in other regions within the range of the race; the differences noted can only be referred to as color phases.

*Haliotis fulgens turveri* Bartsch

*Haliotis fulgens turveri* Bartsch, 1942, Nautilus 56 (2), p. 57

*Type*.—No. 508764, United States National Museum.

*Type locality*.—Magdalena Bay, Baja California, Mexico.

*Remarks*.—Unfortunately, Bartsch used a badly worn, senile shell as his type. A designated paratype in the Turver Collection is extremely similar. Both of these shells are deep and rounded, have dark blue nacre, and have five open pores. The cording is eroded away except for a slight area on the right or growing edge of the shell, but sufficient remains to establish the sculpturing form.

Twenty examples were examined from Magdalena Bay; it was found that 18 had extremely wide, flat, irregular cording, which could be separated easily from that of the nominate race without detailed comparison. The other two shells had wide irregular cording which was still separable, but not as distinctly so. From Turtle Bay, Baja California, 18 of 25 examples were identical to Magdalena Bay specimens. The remaining 7 were similar, but had a more uniform and narrower cording, which probably indicates genetic contact with the more northern populations of the nominate race.

Thirty specimens were examined from Cedros Island, and it was noted that 20 were sculptured with the narrow, rounded, irregular cording of *H. fulgens fulgens*, five were like *H. f. turveri*, and the remaining five were intermediate, fitting neither race yet similar to both.

Bartsch's description, without a figure, appears to be based on a worn senile example (examination confirms this), which could fit almost any population of *Haliotis fulgens*. However, the sculpturing noted and discussed above is consistent, is noticeable without undue comparison of specimens, and is restricted to a distinct geographical region. Hence, I believe that there is a poorly defined geographic race of *H. fulgens* inhabiting the southern portion of the range of the species, from Magdalena Bay north to Turtle Bay, Baja California, Mexico.





Fig. 1. Holotype of *Haliotis fulgens guadalupensis*. Photos by Mead French.

***Haliotis fulgens guadalupensis*, subsp. nov.**

*Type*. — No. H-1-30-60, San Diego Natural History Museum (fig. 1).

*Type locality*. — Collected at South Tip, Morro Sur, Guadalupe Island, Baja California, Mexico. All specimens examined are from this one island. They were collected by divers Robert Clutter, Pete Taylor, and Carl Boyd, all of Scripps Institution of Oceanography, January 30, 1960.

*Description*. — The shell is auriform; the apex of the spire is inset approximately one sixth of the major diameter of the shell and the spire is not elevated. Both the apex of the shell and the dorsal surface are on about the same plane. The siphonal angle is not acute; rather, the shell tends to bend gracefully over this region. There is a shallow, nearly obsolete groove below the siphonal angle. There are seven small open pores on low projections on the type, but in the series examined the number of open pores varies from five to seven. The shell is proportionately deeper and wider than in the other two races. The dorsal sculpturing is distinct; the cording is remarkably uniform and more or less equal in width and height, separated by interspaces of equal width and depth. Close observation shows that the interspaces contain a second set of rather uniform cords, well below the general surface of the shell.

The exterior coloration is dull reddish-brown, but in most specimens this is somewhat obscured by a growth of hard, red sponge. The interior nacre is pinkish, with green and blue iridescent tints. The rather large muscle scar is swirled in pinks and greens. The type is a nearly adult shell, chosen to best illustrate the very distinctive cording.

*Remarks*. — Although some specimens taken in deeper water reach well into the range of size of the nominate race, the average shell is much smaller. Specimens as small as 115 mm. in length exhibit well developed muscle scars, whereas mainland specimens of this size would have only a trace of this scar.

Based upon a formula of length equals 1000, the following ratios are noted: mainland specimens, length 1000, width 744, elevation 219; Guadalupe Island specimens, length 1000, width 810, elevation 293. A comparison of the Guadalupe Island population shows that 87.5% were virtually identical to the type. The remaining 12.5% had variations in the cording, but could be separated easily from either of the two mainland races. *Haliotis fulgens guadalupensis* appears to be an isolated, dwarfed, endemic race of the species. Another abalone, *Haliotis cracherodii californiensis* Swainson, also appears to be endemic to this island.

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